

THE RESULTS OF WOUNDS OF THE LARGE JOINTS MADE BY MODERN MILITARY PROJECTILES.¹

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THE time has not yet come when any modern observer can give the exact percentages of recovery after conservatism, excision, or amputation for gunshot wounds of the greater articulations received during actual warfare. This is because sufficient data have not as yet been collected and published of the Boer-British war to enable us to make such exact statements as those of our own Civil War, the Spanish-American War, and the Philippine casualties enable us to do. I shall not endeavor to present complete statistics giving the exact number injured by small caliber, large caliber balls or shell fragments, because this would consume much time and no commensurate good would result. Nevertheless, an endeavor will be made to clearly indicate the general principles of treatment involved in the several different classes of gunshot wounds. Although in time more exact percentages may be obtainable, it is doubtful whether the figures will materially alter the statements warranted by the data already at our disposal. These I shall lay before you from the clinical rather than from the statistical side, for none of us will be likely, in an individual case, to be deterred from adopting a course which our experience endorses, by a fractional per cent. greater risk shown by statistics. If the majority of such collections of cases show uniformly better results from one method of

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treatment, unquestionably we should be influenced, but not governed, by such knowledge in determining the proper course to pursue in an individual case.

A study from the clinical rather than from the statistical side is all the more necessary when such statements as the following are still found in a modern text-book in use in most of our American medical schools. While I shall not quote *verbatim*, many of the sentences are word for word as there printed. It is asserted that it matters little whether a joint is traversed by a large ball or a fragment of a shell or merely opened by a fissure extending from a wounded long bone, unless amputation or excision is primarily performed, a suppurative arthritis will develop in from forty-eight to seventy-two hours, quickly proving fatal, although in some instances recovery may ensue after months of suffering with a crippled joint, or only after a secondary resection, or, more often, an amputation.

Let me briefly state the data upon which such statements are founded, emphasizing the fact that they resulted from an exaltation of statistics over clinical observation, which even before 1898 showed conclusively that, however true the conclusions possibly were for the period up to about 1876, they were becoming less reliable with every passing year. Unfortunately, the old views still decidedly tincture modern practice, hence my protest in the shape of this paper.

During the Civil War wounds of the shoulder-joint gave a mortality of 27.5 per cent. under conservative treatment, which was, of course, reserved for the slighter cases; after amputation, 29.1 per cent. died, while the combined mortality of primary, intermediary, and secondary resections was 35.43 per cent., that of the intermediary operation reaching the appalling figures, to the modern military surgeon, of 46 per cent.

The elbow-joint, considering its more superficial position and more favorable anatomical environment, shows not very much better results,—the mortality after expectant treatment being 10.3 per cent.; after excision, 22.4 per cent.; amputa-

tion at the lower third of the arm having a mortality of 20 per cent. The aggregate mortality, after all methods of treatment, was 19 per cent. By expectant treatment the death-rate for wrist-joint wounds was 7.6 per cent., while by all other methods combined the mortality was 25.90 per cent.

From the same source the figures show that conservatism in gunshot wounds of the hip-joint practically meant death, the mortality being given as 98.8 per cent. The combined death-rate of primary, intermediary, and secondary excisions gave somewhat better results, 85.5 per cent. only perishing, while the secondary excisions enable one to give a sigh of relief when we find that only 63.4 per cent. died. The results of amputation at all periods were about the same as for excisions, viz., 89.9; this apparently good showing, however, being due to a not inconsiderable number of reamputations of stumps, since the secondary amputations gave a much higher death-rate (82.5 per cent.) than do secondary excisions (63.4 per cent.). The results during the Franco-Prussian War are not really much more encouraging, thirty-one out of thirty-three wounds of the hip perishing under conservative treatment (*i.e.*, 93.63 per cent.); eighteen out of twenty excisions died (85.7 per cent.), while the eleven subjected to amputation perished (100 per cent.).

Of 432 cases observed during the Civil War, even where no lesion involving the bones constituting the knee-joint existed, ninety-five died, *i.e.*, 21.9 per cent. The ultimate results of forty-four out of fifty-four excisions reported give a death-rate of 81.4, exceeding that of low amputations of the thigh, viz., 53.8.

The Schleswig-Holstein War gave for excisions a mortality of 86.6 per cent.; for those done during the Franco-Prussian War, 80 per cent.; while all died (100 per cent.) during the Russo-Turkish War of 1876 to 1877. Otis reports 133 resections collected from all sources, from civil life as well as military practice, with thirty-five recoveries, a mortality of 73.2 per cent. It would appear that conservatism even then gave a better showing than my text-book quotation would

indicate. Although this treatment would doubtless be employed for the less severe cases, yet of 868 with bone lesions so treated, many of which were serious, only 521 resulted fatally, a death-rate of 60.6 per cent. According to Otis, of 512 wounds of the ankle-joint treated conservatively, 407 recovered and ninety-nine died, a mortality of 19.5 per cent. Of thirty-one excisions where the results were finally determined, twenty-two recovered and nine died, a mortality of 29 per cent.; finally, an average death-rate of 25.1 obtained for amputations performed at all periods. This formidable array of figures superficially scrutinized warrants the pessimistic views quoted. In the light of modern science, a more careful study, however, suggests a rather different conclusion as possible. Although it is true that conservatism was reserved for what were supposed to be the less severe injuries, with the exception of wounds of the hip, the results were so vastly superior to those secured by operation that one cannot but harbor the suspicion that some of the mortality was due to meddlesome surgery, and that a number of cases where primary operations were deemed requisite might have done as well as the slighter cases did, provided the surgeons had not infected the wounds, and free drainage had been secured by the same measures employed in the so-called conservative treatment, *i.e.*, removal of bone fragments after enlargement of the wound.

Before attempting to explain the differing results obtained by the old and the new methods of treating gunshot wounds of the joints, let me give the clinical results secured during the past four years in the United States army. Without going into unnecessary minutiae, I have found reported 161 wounds of the shoulder-, elbow-, wrist-, hip-, knee-, and ankle-joints, paralleling those quoted in the Civil War statistics. These may seem a small number, but when I state that so far as reported exactly similar results were obtained in South Africa, and when you observe that serious operations were rare, that conservatism—chiefly antiseptic occlusion—and fixation were the rule, and that deaths after both operative and non-operative

treatment were extremely rare, you cannot fail to recognize that my quotation is a most pernicious doctrine, and one absolutely unsupported by modern clinical facts.

Six wounds of the hip-joint gave five recoveries and one death from infection after removal of bullet, fragments of jacket or bones. Sixty-seven cases of knee-joint wounds are reported with but five deaths at the date of publication; two fatal amputations for infection followed the removal of the bullet or some fragments, ten cases in all only apparently demanding extraction of the bullet, fragments of bone or shell. Twenty wounds of the shoulder-joint were followed by two deaths, one after amputation, and in a third case a successful extraction of the bullet was done. Of twenty-five wounds of the ankle-joint two died after amputation, one operation being done for gangrene, and in one other case a bullet was successfully extracted. Thirty-five wounds of the elbow-joint gave but one death, one typical resection being requisite; the bullet or ball and bone fragments were removed in four more, and in three, amputations became later necessary for infection, this almost certainly resulting from previous exploration or operative intervention. Nine wrist-joint wounds were treated without a death and with only one operation, viz., an amputation. No figures are needed to show exact percentages, and these would probably not be accurate, because subsequent deaths or operations may have followed alleged recoveries apparently secured when reported; nevertheless, seven amputations for ball wounds of the knee,- shoulder-, ankle-, and wrist-joints, one resection of the elbow, about a score of removals of bone fragments or bullets, wiring of fragments, etc., with an ascertained mortality of only ten out of a total of 161 cases, speaks for itself. Lest I seem too optimistic, let me quote the experience of Mr. Makins in South Africa. "During the present campaign, direct clean wounds of the joints were little more to be dreaded than uncomplicated wounds of the soft parts alone. No more striking evidence of the aseptic nature of the wounds, and the harmless character of the projectile, as a possible infecting agent, than

that offered by the general course of these injuries in this campaign, is to be found in the whole range of military surgery."

While there are doubtless other factors productive of these changed results, I think the chief ones are the following: First, the practice of many of the Civil War surgeons was unconsciously influenced by the mediæval notion that in some mysterious way gunshot wounds differed from others of the same class, *i.e.*, combined punctured and contused wounds; hence something must be done, and of course something different from that which was indicated for similar wounds produced by other vulnerating bodies than bullets. Then, too, it was deemed most important to ascertain the exact extent of the damage, for unaided nature could not be trusted, but must be assisted by art. The gratification of this knowledge, of course, more often determined infection than relieved it, and the modern methods of drainage were unknown. Finally, the almost unbounded power of repair possessed by the tissues, if left to themselves, has been a modern revelation. In other words, infection by the probe and fingers, additional traumatism still further diminishing the resistance of the tissues, no knowledge of how to successfully combat and render comparatively inert the results of infection, had more to do with the dangers of the older missiles than their form, composition, or the kind of destruction effected. Unquestionably, because the old ball had a low velocity, was large in caliber, and apt to become deformed, it tended to carry fragments of infected clothing, skin, etc., into the wound. Still further, its "energy" was so low that it frequently did not perforate the parts, the "energy" was diverted, and extensive devitalization of the tissues resulted, favoring infection, and the infected foreign body often remained lodged. This was bad enough when true; but often, when the ball had done little or none of these things, the pernicious idea that the ball was in itself a menace to life and health lead to the infection of joints which would otherwise have recovered; the modern gospel, "that a bullet when it has ceased to move has usually

ceased to be harmful," at least primarily, did not seem to be dreamed of.

The lessened morbidity of modern missiles is explainable, first, from their smooth polished surface rendering them poor vehicles for germs, in fact, the jacketed balls have been proven in most cases to be germ-free. Then from their small caliber and smooth surface they almost never carry in with them fragments of infected clothing or skin. Finally, because their velocity is such that perforation is the rule, comparatively little of the "energy" is diverted, unless marked resistance is met with, which cancellous tissue does not present, and the area of devitalized tissue is therefore less than with the old missile, thus rendering infection less likely to occur, and when it does obtain, rendering it not so dangerous; the missile also comparatively rarely lodges.

In brief, the dangers to life, and in a great measure to function, of a wound of any joint is infection. In a certain number of instances undoubtedly the physical destruction of joint surfaces must cause restriction of function. Even with free comminution, however, the subsequent range of motion is often remarkable. Thickening of and adhesions between the soft parts, intra- or extra-capsular, with capsular changes, often does more harm in the way of limitation of movement than does physical alterations of the articular surfaces; and, per contra, with the alteration of joint surfaces such as occurs in closed fractures involving articulations, an eventually good functional result is the rule, if reduction is secured and maintained, unless unusual inflammation occurs. In this connection it must be remembered that displacement of bone fragments by modern balls is very often slight, and that the cancellous extremities of bones are often cleanly perforated, or but slight fissuring occurs. If, then, we can avoid infection, an articulation may be damaged to any extent by a modern small caliber military missile with impunity, so far as life is concerned, and, despite free comminution, in many instances excellent functional results can be secured.

Treatment.—I cannot do better than to preface my own

advice as to treatment by quoting from Mr. Makins's experience of joint wounds, one who speaks from personal knowledge acquired, as my own is, both in civil and in military practice. "The general treatment of the wounded joints was simple. The old difficulties of deciding on partial as against full excision or amputation were never met with by us. We had merely to do our first dressings with care, fix the joint for a short period, and be careful to commence passive movement as soon as the wounds were properly healed, to obtain in the great majority of cases perfect results." Speaking of the knee-joint he says, "The injuries to this joint gave less anxiety and attained a more favorable prognostic character than is the case in civil practice." With a probable or certainly perforating wound of a great joint, whether proven by the course pursued by the ball, bone-dust at the wound of exit, palpation proving fracture, or the X-ray, or with a wound suspected to be a joint one on good anatomical grounds, the proper treatment is most carefully to avoid any examination of the track of the ball, and to thoroughly disinfect the neighboring parts by sterilized soap, nail-brush, alcohol, and chemical germicides. Of course, shaving the area surrounding the parts must be done. An abundant dry antiseptic or aseptic dressing—preferably the former—should be applied, and the joint adequately fixed *until the wound is healed*. Of course, few, if any, of these procedures can be carried out on the field, but antiseptic occlusion by the first-aid package can be done, and some measure of fixation can be secured by one of the makeshifts so familiar to the military surgeon. Where such complications as hæmorrhage from contiguous vessels, the certain or extremely probable lodgement of infected objects, as fragments of clothing, etc., compel an exploration, after the most careful antiseptic preliminaries the wound must be explored, the complications dealt with, and such completely or almost completely separated bone fragments as will necessarily perish if infection follows the intervention, and must then act both as foreign bodies and as obstacles to drainage, should be removed, while all main attached fragments should be replaced,

and either wired or sutured in position. Free drainage must be secured by gauze, preferably by tubes introduced through any required number of incisions into the joint, and fixation made, remembering the great risk to both life and function is pyogenic infection, which is extremely probable after exploration, and that the only efficient means we have to combat infection is, after the primary disinfection, to secure the promptest possible removal of all inflammatory secretions as soon as they are formed. It is almost of equal importance to prevent all movements of the articulation which will mechanically diffuse the infection more widely. Movement also maintains and increases hyperæmia, which in turn impairs the nutrition, and hence the resistance of the tissues, thus often converting a local into a wide-spread infection. When the constituent articular ends of the bones composing a great joint during exploration are found so damaged as to apparently demand formal resection—especially in case of the knee—and where, therefore, the dangers of infection are exceptionally great, amputation will usually prove the better practice. This only more strongly emphasizes the imperative duty of non-interference in wounded joints, unless complications such as hæmorrhage or the lodgement of infected objects demand exploration, because it is almost impossible to secure an aseptic course for the wound when dealing with such large areas of partially devitalized tissues.

But supposing the ball is lodged in the joint? Even in such cases, if uninfected, risk to life is absent, and delay in removal of the missile, unless superficially tangible, will enable the damaged tissues to regain much of their resistance to infective organisms. The fact of its location within or without the joint can also be ascertained by the X-ray, sometimes preventing the performance of an operation on the incorrect diagnosis of an intra-articular missile. I would most earnestly beg surgeons in all cases of suspicious wounds *near* joints which *may* have opened the capsule, to beware of primary exploration, even if the missile be lodged, to fix the joint until the wound heals. When this cannot be done, if possible, post-

pone the extraction of an extra-articular ball at least until the capsular wound has had time to close, otherwise slight, almost latent deep-seated, suppuration may lead to the most disastrous results.

When, however, infection has occurred either from exploration or because of the lodgement of infected materials, what should be done? Unless the general symptoms indicate that no delay is possible, when amputation is demanded, incision with free tube drainage and scrupulous disinfection should be tried, all loose bone fragments or those practically certain to necrose being removed. This will usually succeed with the elbow, often with the shoulder, possibly with the ankle. It will prove the best treatment, I believe, for the hip. Doubtless a transverse incision in front of the knee dividing the patella, with antiseptic packing of the joint after removal with knife, scissors, or curette of all possibly infected soft parts and loose bone fragments, will save a certain number of limbs and lives when infection occurs in cases with slight bone lesions, secondary suturing of the patella being done later. Secondary resection may become requisite for caries or necrosis of fragments. When the local and constitutional evidences of infection increase despite drainage, amputation remains the only resort and should not be delayed. In like manner, secondary hæmorrhage from a main vessel complicating an infected joint-wound would indicate removal of the limb. I have spoken of "nearly certain lodgement of infected fragments of clothing" as a possible indication for exploration, a phrase which needs interpretation. While the majority of military wounds are inflicted by small caliber, jacketed balls, such as the Mauser, Lee-Metford, Krag, and similar weapons project, moving with great velocity, these balls may be deflected by ricochet, or be deformed before wounding; hence they are nearly as likely as the old bullets to carry in fragments of clothing, pieces of shoe leather, or infected skin, especially that of the foot. The character of the external wound will often prove that the missile was deformed or entered more or less sideways, hence has possibly inflicted an infected wound.

Sometimes in such cases, even when examined comparatively soon after the injury, there are clear evidences of commencing infection. Again, soft lead pistol-balls are still employed, blunt and pointed Remington .45 caliber balls, Martini-Henry projectiles, together with the soft lead balls of shrapnel shell may be the vulnerating bodies. All these possess a low velocity; some are apt to become deformed, all tend, when partially spent, if meeting with moderate resistance, to enter more or less sideways, hence are apt to carry in infected materials.